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reviewer is ready to agree with his conclusion that "the watchwords of a rational and reasonable ecology are logic, common sense, and physiological experimentation," and perhaps to echo his "We do not need their dogmatism nor their abominable nomenclature; we have enough of our own."—GEO. D. FULLER.

Alpine adaptations.—In 1884 BONNIER began his classical experiments upon the structural changes induced by growing plants at various altitudes. Plantations were made in the lowlands and at various altitudes in the Alps, so arranged that the two individuals to be compared were produced by dividing one plant. Similar experiments were begun in the Pyrenees in 1886, and the botanical world is familiar with the remarkable results as reported in BONNIER's earlier publications. Now after a lapse of over 30 years he makes a summary of what are probably the most notable and prolonged experiments of their kind on record.[10]

A few of the plants taken from the plains to alpine stations died, but a list is given of 58 species that proved able to maintain themselves at high altitudes. These have all undergone changes which make them closely resemble indigenous alpine plants. The principal changes are relatively large development of the subterranean as compared with aerial parts, shortening of the leaves and of the internodes of stems, increased hairiness, and relatively larger development of bark and protective tissue. The leaves became thicker in proportion to their surface and are a deeper green, with more highly developed palisade tissue and a larger number of chloroplasts, while the flowers are larger and more highly colored. In at least 17 species the changes are so great that the plants have apparently been transformed into distinct alpine "species." Thus *Lotus corniculatus* L. began to show decided modifications within 10 years, and finally became identical with *L. alpinus* Schleich; *Helianthemum vulgare* Gaertn. has in 30 years become *H. grandiflorum* DC.; while *Leontodon proteiformis* Vill. in 6 years is completely transformed into *L. alpinum* Vill.

For all the species able to maintain themselves with considerable altitudinal range, there seems to be an optimum altitude at which the transformations are most rapid, most complete, and where intensity of color and development of chlorenchyma reach a climax. Species of *Potentilla* may be cited as indicating individual differences of range. Thus the optimum conditions for *P. argentea* appear to be found at 1050 m., for *P. reptans* at 1500 m., and for *P. tormentilla* at about 2000 m. Cultures of alpine plants at lower altitudes showed reversed although less marked transformations. Alpine species, able to maintain themselves at various altitudes, at the lower stations gradually lost many of their typically alpine characteristics, and a list of 14 species showing such changes is given. Certain annuals taken from the plains and transplanted to high altitudes became biennials or perennials, as *Poa annua* and *Senecio viscosus*, while *Calamintha acinos* became not only perennial but subfruticose.

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[10] BONNIER, GASTON, Nouvelles observations sur les cultures expérimentales à diverses altitudes et cultures par semis. Rev. Gén. Bot. **32**:305–326. *pls 2. figs. 4.* 1920.

In 1919 seeds from known individuals were sown on July 1 at Fontainebleau at an altitude of 78 m., and in the Pyrenees at 2000 m. The resulting plants were compared on September 30, and all at the alpine station showed decided dwarfing. In spite of the fact that many species did not reach maturity in the mountains, several showed the mature form of leaf earlier than in the lowland. Some species, such as *Sinapis arvensis* and *Centaurea cyanus*, proved by their flowering that the dwarfed alpine individuals were quite mature. Many of the alpine forms exhibited a decidedly increased development of hairs and of anthocyan.—GEO. D. FULLER.

Lycopodium.—HOLLOWAY,[11] in his fourth paper on New Zealand species of *Lycopodium*, presents sections PHLEGMARIA and CERNUA, the former represented by *L. Billardieri*, with its var. *gracile*, and *L. varium*, the latter by *L. cernuum*, *L. laterale*, and *L. ramulosum*.

In the PHLEGMARIA group the general form of the prothallium "consists essentially of a central body of tissue which may be either bulky or more or less elongated, and a number of branches which arise adventitiously from the central body." The plants are dorsiventral and the sex organs zonate. The latter arise "immediately behind the apex" of either the main body or the branches, and are associated with numerous paraphyses. The archegonia occur only on the central body. The endophytic fungus may occupy the entire mass of cells of the main body when young, except the generative tip and the epidermis. In the older plants there is a central layer of elongated cells free from the fungus, probably functioning as "translocation tissue." The identity of the fungus has not been settled, but HOLLOWAY has shown the sporelike bodies observed by other investigators. His figures of the fungus in *L. Billardieri* show exactly the habit of the fungus in the prothallia of *L. lucidulum* observed by the reviewer. The same thing is probably to be found in the prothallium of *L. Selago*. The relationship of the four embryonic organs is well shown in fig. 34.

There is an excellent discussion of body form, comparing prothallia of this section with those of the *Selago* group. HOLLOWAY states that the *Phlegmaria* type of prothallia is "the extreme attained by the cylindrical type of growth"; and that the *clavatum* type is "the extreme attained by the continued conelike manner of growth."

In considering the representatives of CERNUA, most attention is given to *L. ramulosum*. It is an interesting fact that chlorophyll never occurs in the lower part of the prothallium. The fungus is limited to shallow zones, is

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[11] HOLLOWAY, Rev. J. E., Studies in the New Zealand species of the genus *Lycopodium*. IV. Trans. New Zealand Inst. 52:193–239. 1920.